4. Proposed Action

4.1 Recommended Plan

The most technically feasible, cost effective and environmentally friendly alternative for the City of Rehoboth is a dedicated ocean outfall (Alternative 6).

A summary of the primary reasons for selecting this alternative follows:

- Due to the 2002 consent order, the No Action alternative is not feasible and would likely result in legal action taken by the DNREC against the City.
- The Nutrient Trading option is infeasible because trading partners in the watershed are limited.
- Land application is not a feasible alternative because the required land was not available and working with the county was determined not to be feasible. It was also significantly more costly than the ocean outfall alternative. However, as a point of comparison, the land application alternative is considered as a possible alternative in the environmental impact evaluation presented in Chapters 7 through 9.
- Rapid Infiltration Beds were dismissed because of the lack of required land, potential groundwater mounding issues, and the continued introduction of nutrients into the groundwater.
- Subsurface injection is not a viable alternative because of the lack of a suitable aquifer and the significant risk associated with this approach.
- Computer modeling of the outfall indicates that, even under worst-case scenarios regarding the performance of the wastewater treatment plant, public health requirements are met at or in close proximity to the diffuser.
- After a number of public workshops and hearings, the ocean outfall emerged as the alternative preferred by the citizens of the City of Rehoboth Beach for various reasons associated with environmental issues and cost.
- The outfall is the most favorable alternative on a long term present worth basis. After the initial 20 years of operation, the City would have paid off the debt and would only have O&M costs remaining in the continuing years. The land application alternatives would require the City to make payments to the County or to a private utility (or both) in continuing years.

4.2 Existing Ocean Outfalls

4.2.1 Introduction

The use of ocean outfalls to discharge wastewater to the marine environment has been a common practice for coastal communities around the world for over a century. The level of treatment provided has varied from no treatment to primary settling or secondary treatment with or without disinfection. In the United States, the Clean Water Act of 1972 required that all municipal wastewater treatment plants provide a secondary level of treatment prior to discharge to the environment. Some communities were able to obtain a waiver from the government by demonstrating that the discharge of only primary treated wastewater would achieve water quality objectives because of the high degree of dilution and the assimilative capacity of the ocean and that imposing a requirement for secondary treatment would be an economic burden. These exceptions, known as a 301(h) waiver, were site specific based on the physical characteristics of the ocean including depth, circulation patterns, distance from shore etc. Some of the 301(h) permitted discharges continue today, but others have been upgraded in response to environmental issues or public pressure.

As a matter of perspective, the proposed outfall for the City of Rehoboth Beach would discharge an effluent, which is treated to even higher standards then just secondary. The RBWWTP is an advanced wastewater treatment facility that provides, in addition to secondary treatment, effluent filtration and nutrient removal.

4.2.2 Delaware

The South Coastal WWTP discharges treated municipal wastewater through a 30-inch outfall located on the south side of Bethany Beach. The outfall was built in 1977 and extends 6,000 linear feet (1,830 meters) offshore. The WWTP has a design capacity of 9.0 MGD. The South Coastal WWTP provides an advanced level of treatment very similar to the current treatment requirements for the RBWWTP. The DNREC samples beach water quality once per week for bacterial contamination. There have been no environmental issues associated with this ocean outfall discharge. In fact, Bethany Beach has typically received some of the highest ratings from the National Resources Defense Council (NRDC) in their annual ratings of beaches nationwide.

4.2.3 Maryland

Ocean City, Maryland built an ocean outfall in 1970 to discharge treated effluent approximately 4,600 feet offshore at a depth of 30 feet. The plant provides a secondary level of treatment and has a design capacity of 16 MGD. The NRDC has also consistently rated the Ocean City beaches very high.

4.2.4 New Jersey

The State of New Jersey has 14 ocean outfalls discharging treated municipal wastewater along its 127 miles of coastline (American Littoral Society 2002). The total permitted capacity of the outfalls is 220 MGD. The outfalls discharge from 1,600 to 8,000 feet offshore. The plants provide secondary treatment with chlorine disinfection.

4.2.5 Florida

Florida has six ocean outfalls located in the southern part of the state. They discharge municipal wastewater treated to a secondary level. The discharges are all located in the western portion of the north-flowing Florida Current. The distance of the discharge from shore ranges from slightly less than one (1) mile to just over 3.5 miles. Biotoxicity testing of the plant effluents concluded that the diluted effluent had no toxic effects on marine organisms (Hazen and Sawyer 1994). The outfalls were extensively studied in the 1990s by the National Oceanic and Atmospheric Administration (NOAA), the Florida Department of the Environment and the EPA in a project referred to as the Southeast Florida Outfall Experiment (SEFLOE I and SEFLOE II). The studies collected information regarding the mixing, dispersion and dilution of the effluent plumes and on the environmental characteristics of the outfall sites and receiving waters. The study concluded that there should not be any adverse effects resulting from the ocean discharge of secondary-treated effluent (Hazen and Sawyer 1994).

Several more recent studies suggest that, in a few specific cases, nutrient enrichment may be having an adverse effect on nearby coral reefs (Tichenor 2004). Legislation has been proposed to decrease southern Florida's dependence on ocean outfalls by requiring that 60% of the utilities' wastewater be disposed of by reuse methods and that no new ocean outfalls be constructed. However, due to the economic impacts, legislation was recently enacted to extend the compliance deadlines.

4.2.6 California

There are 37 ocean outfalls in California discharging over 1.5 billion gallons of treated wastewater each day. Some of the discharges were originally permitted under the EPA 301(h) waiver that allowed the discharge of primary treated wastewater. Orange County Sanitation District, for example, discharges 245 MGD of a blend of 65% secondary treated water and 35% primary effluent. In 2002, the District began to disinfect all of the effluent. There is a general trend to upgrade the level of treatment provided in California for all ocean discharges.

4.3 Wastewater Treatment Plant

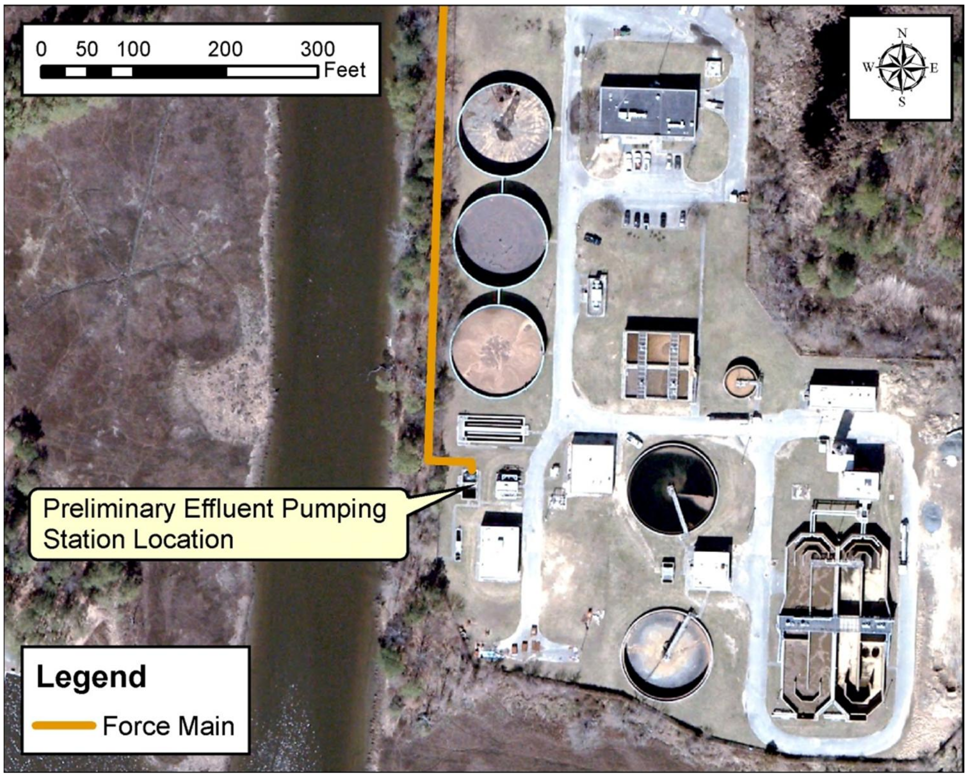
It is expected that the DNREC will impose discharge limits on an ocean discharge that are identical to the limits currently imposed on the South Coastal RWF that discharges through an ocean outfall located south of Bethany Beach, Delaware. These limits are summarized in Table 4-1. The advanced treatment for nutrient removal currently provided at the RBWWTP provides a level of treatment greater than that which would be required by the anticipated discharge permit. However, in order to improve the reliability of the existing WWTP and to pump the flow to the new proposed outfall, improvements to the WWTP are planned. These improvements include upgrades to the motor controls and power distribution, emergency power generation, headworks, effluent filtration system and solids handling equipment.

Table 4-1 Anticipated National Pollutant Discharge Elimination System (NPDES) Permit Limits for Ocean Discharge based on Current Limits at South Coastal RWF (USEPA 2005)

Parameter	Permit Requirement	Unit	Basis
BOD_5	15	mg/L	Daily Average
TSS	15	mg/L	Daily Average
pH	6.0 – 9.0		

A new effluent pumping station would be required at the RBWWTP to pump the treated effluent through the force main and outfall pipe to the outfall diffuser. The pumping station would be constructed within the site limits of the existing WWTP and would not require expansion or the acquisition of new land. The preliminary plan is to convert the existing reaeration tanks at the treatment plant to wet wells and install three (3) vertical turbine pumps with variable speed drives. The preliminary location of the effluent pumping station is shown in Figure 4-1.

Figure 4-1 Preliminary Effluent Pumping Station Location



4.4 Force Main

4.4.1 Alignment

The pipeline from the RBWWTP to the ocean outfall was sized to handle the summer peak flow of 7.2 MGD. A detailed alignment study was completed to determine the best routing of the force main considering such issues as cost, environmental issues, permitting, potential interferences, traffic control and public concerns. The preferred alignment was selected based on the recommendations of the Rehoboth Beach Wastewater Treatment Plant Effluent Force Main Alignment Study attached in (Appendix G).

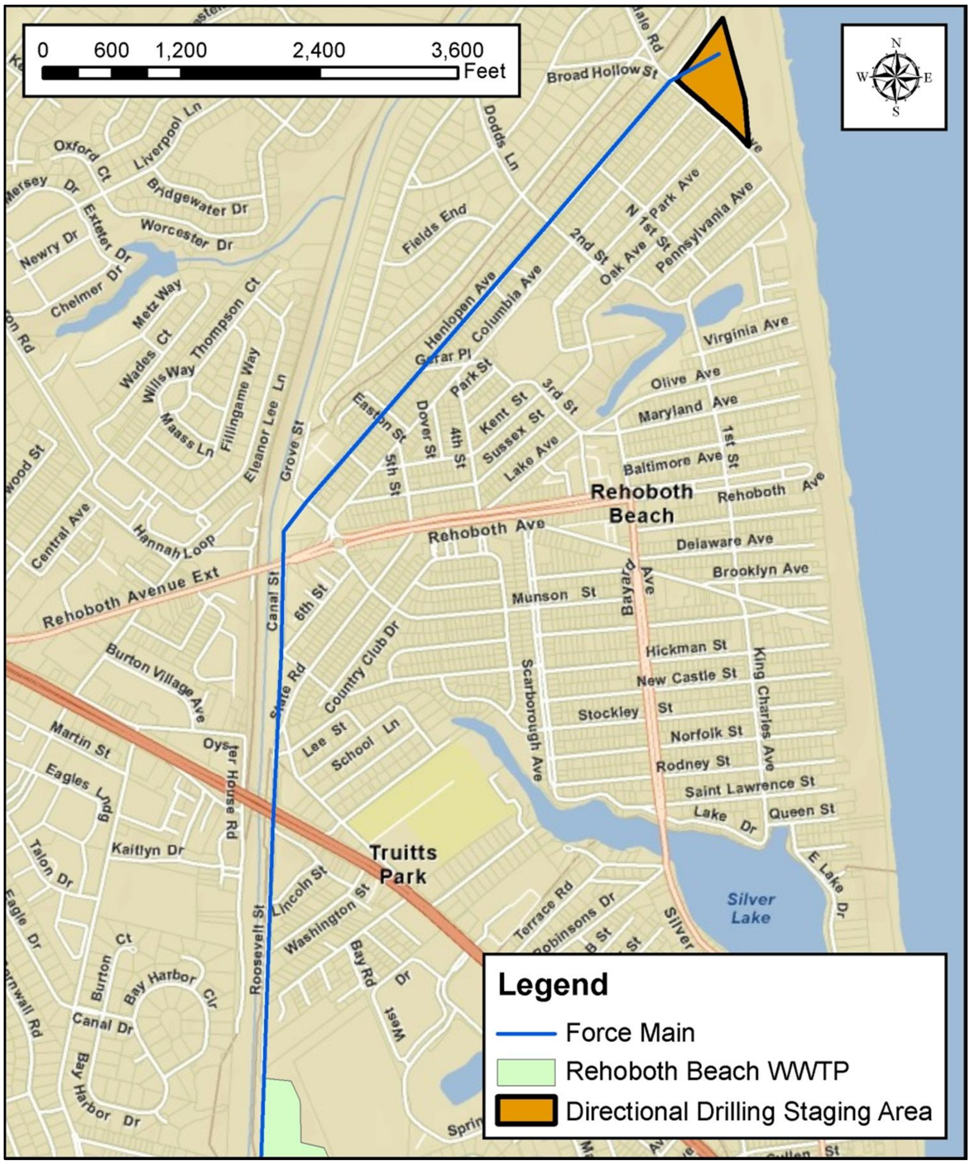
The proposed alignment for the force main is shown in **Figure** 4-2 and is as follows:

- North from the effluent pump station at RBWWTP along the edge of canal until reaching plant entrance road
- In Right of Way of plant access road, under Rt. 1 Bridge
- Continue on State Road under Rehoboth Avenue to Grove Park
- Under Grove Park, turning northeast towards Henlopen Avenue

- In Right of Way of Henlopen Ave. to the Deauville Beach parking area
- Connect to ocean outfall pipe

The proposed alignment will predominately follow existing utilities and right of ways.

Figure 4-2 Force Main Plan



A review by the DNREC, Delaware Division of Parks and Recreation (Clark 2011) was performed during the November 2011 under the provisions of Section 106 of the National Historic Preservation Act (amended 1966) and in coordination with the Delaware State Historic Preservation Office. It was concluded that the ocean outfall project is an undertaking for Section 106 review that has the potential to affect historic properties in limited areas of force main construction on land and offshore. Offshore discussion review can be found in Chapter 9.

According to the DNREC review (Clark, 2011), The City of Rehoboth Beach developed from a farm to a resort community in the late 19th century in a setting that has been occupied over time by Native American, Afro-American and European settlers. Though historic buildings will not be affected by the project, Columbia Avenue is an historic concrete road, which may be a contributing element to the 1937 modern subdivision of Henlopen Acres. Therefore, additional evaluation and measures to avoid open cut construction in Columbia Avenue are recommended for the force main option (Clark 2011).

In addition, the Lewes and Rehoboth Canal is an historic structure which was completed through Rehoboth by the mid-1920's. Thus, there is a potential that spoil from construction may overlie the banks of the canal and protect a buried historic landscape in this vicinity. Potential archaeological sites may include both historic and Native American sites. It is expected that limited archaeological survey will be necessary in areas of open cut force main construction, including the area oat Deauville Beach, that are outside of the street layout. For open cut construction within the street layout on Henlopen Avenue, no archaeological survey is recommended because buried utilities from stormwater, sewer and lateral connections have widely disturbed the underlying soil stratigraphy. Thus, Alternative A in the Rehoboth Beach Wastewater Treatment Plant Effluent Force Main Alignment Study attached in (Appendix G) and as noted in the above figure, the force main route along the Lewes Rehoboth Canal and within Henlopen Avenue, is the preferred alternative (Clark 2011).

4.4.2 Construction Methods

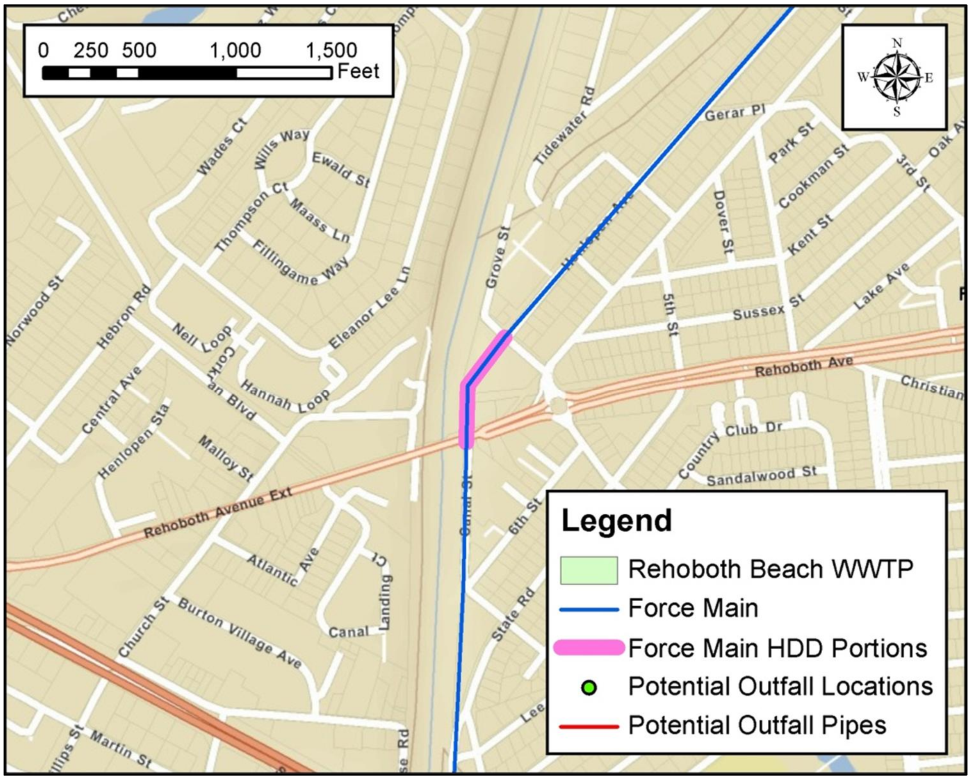
Two construction techniques will be utilized for construction of the force main. They include:

- Horizontal Directional Drill (HDD)
- Open Cut Installation

The extent to which each method is proposed to be utilized is based on the desire to avoid disturbances to trees and historical sites and minimize conflicts with existing utilities, while also minimizing cost.

The majority of the proposed force main from the effluent pumping station at the RBWWTP to the ocean outfall staging area will be constructed within either the Army Corps of Engineers or street right-of-ways. This will allow approximately 10,600 linear feet (3,230 meters) of the 11,400 linear foot (3,470 meter) force main to be constructed utilizing open cut installation. The remaining 800 linear feet (240 meters) within Grove Park would require HDD in order to minimize impact to this area. The proposed portion of the forcemain to be directionally drilled is presented in **Figure** 4-3.

Figure 4-3 HDD Portion of the Proposed Effluent Force Main



4.5 Ocean Outfall

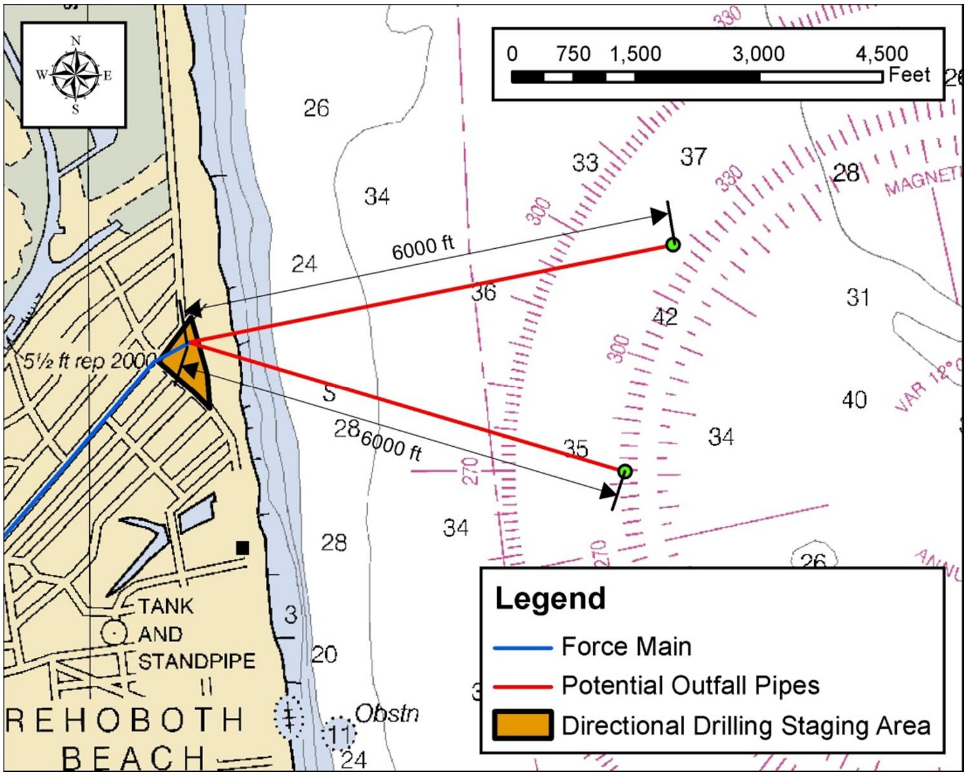
4.5.1 Location

The Effluent Disposal Study (Stearns & Wheler 2005) identified the general location for the proposed ocean outfall. Two specific locations within this general area are investigated in this report as potential outfall locations. At either location, an outfall pipe will would extend 6,000 linear feet (1,830 meters) east from the termination of the land-based forcemain within Deauville Beach parking area. The ocean outfall pipe would terminate with a diffuser pipe at a water depth of approximately 40 feet (12 meters). The specific locations that were evaluated for the ocean outfall are detailed in **Table** 4-**2** and shown in Figure 4-4. **Figure** 4-5 provides a broader perspective of the outfall location and shows that the outfall in relation to the Hen and Chicken Shoals.

Table 4-2 Proposed Ocean Outfall Locations

Location	Coordinates	Perpendicular distance from shore
North Location	N 38° 43.787', W 75° 03.505'	5,430 ft (1,660 m)
South Location	N 38° 43.333', W 75° 03.631'	4,430 ft (1,350 m)

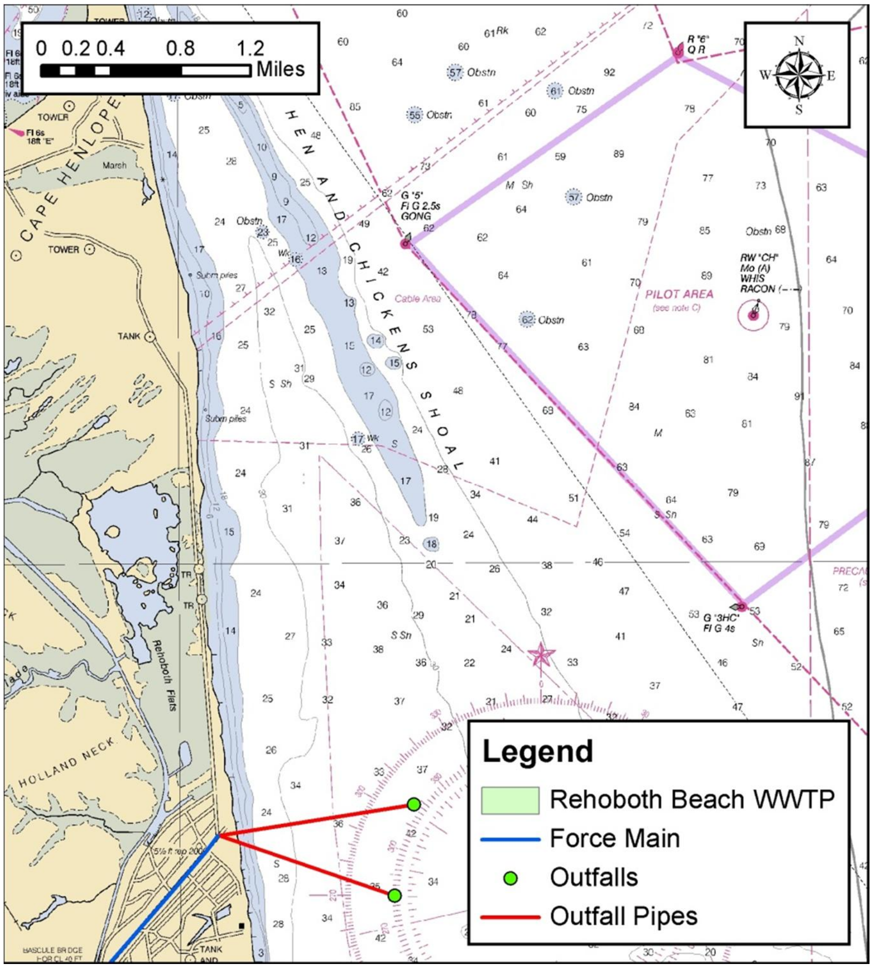
Figure 4-4   **Proposed Ocean Outfall Locations**



The proposed location is based on preliminary modeling performed for the 2005 Effluent Disposal Study by Lawler, Matusky & Skelly Engineers, (included in (Appendix D)), which shows that adequate dilution will occur at 5,430 linear feet (1,830 meters) from shore. The proposed location to exit the beach area was chosen because it offers a convenient area for staging the construction and because the routing of the force main from the RBWWTP to this point was relatively straightforward. Alignments to the south of the City would be more difficult. Also, outfall locations to the north are limited by the presence of Cape Henlopen Park and to the south by the boardwalk and the congested city area.

The Deauville Beach access parking lot located at the intersection of Henlopen Ave and Duneway provides adequate space for construction and should minimize disruption to local businesses and residences.

Figure 4-5 Location of Hen and Chicken Shoals



4.5.2 Outfall Pipe

Based on the conceptual design, the outfall will be a 24 inch diameter pipe extending 6,000 linear feet (1,830 meters) from the Deauville Beach access parking lot to a diffuser. **Figure** 4-6 shows a profile of the ocean outfall pipe. The details of the profile will vary depending on the construction technique utilized as explained in Section 4.5.4.

Figure 4-6 Ocean Outfall Profile (Not to scale)

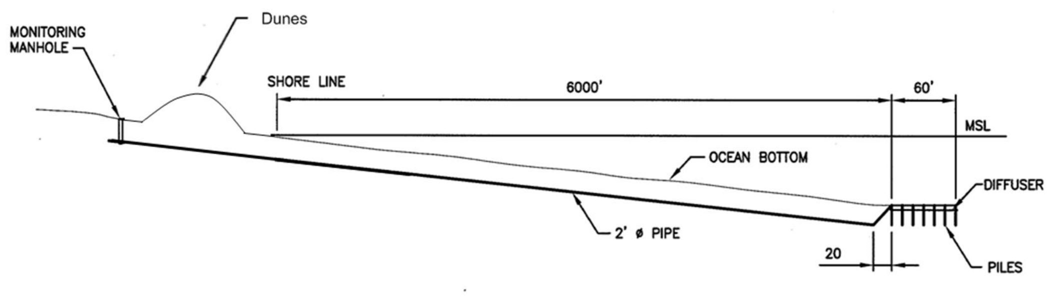
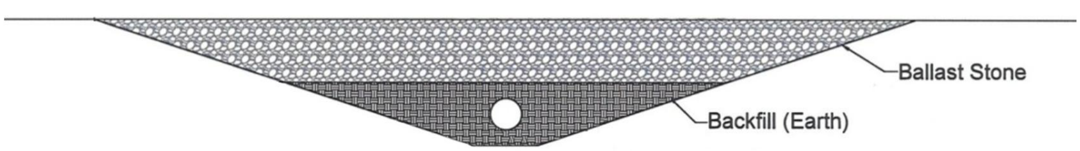


Figure 4-7 presents a cross-section for the ocean outfall pipe for the section installed by excavation. The following criteria were used to develop the cross-section:

- Pipe trench has a slope of 1.5:1.
- Trench bottom will be 1 foot (0.3 meter) wider on each side than the pipe diameter.
- The sandy soil in the excavated trench will provide the pipe bedding.
- The pipe will be anchored in the trench with concrete collars.
- 2.5 feet (0.8 meters) of backfill will be laid over the pipe.
- 4 feet (1.2 meters) of ballast rock will be laid over top of the backfill to help keep the pipe submerged and to protect it from scour.
- Armor rock will be laid over the trench at a 2.5 foot (0.8 meter) depth and a side slope of 30°.

Figure 4-7 Typical Ocean Outfall Cross Section



4.5.3 Diffuser

A preliminary design for a diffuser was developed for the outfall in the "Rehoboth Beach Wastewater Treatment Plant Effluent Disposal Study" (Stearns & Wheler 2005), based on generally accepted best practices for diffuser design. The basic design criteria utilized within the 2005 report were as follows:

- Selection of a Y-Type diffuser to accommodate expected widely varying flows
- Froude number greater than one (1) to ensure adequate mixing

- Nozzle exit velocity greater than three (3) feet per second (0.9 meters per second) to avoid sedimentation
- Nozzle exit velocity less than 10 feet per second (3 meters per second) to avoid excessive head loss
- Riser spacing between eight (8) to 15 feet (2.4 to 4.6 meters)
- Riser spacing ratio (diffuser length / distance between risers) greater than four (4)
- Between 10 and 15 feet (3 to 4.6 meters) of diffuser length per mgd of flow

A sensitivity analysis was performed on the 2005 diffuser design to determine the effect that several design parameters had on the dilution achieved (Stearns & Wheler 2005).

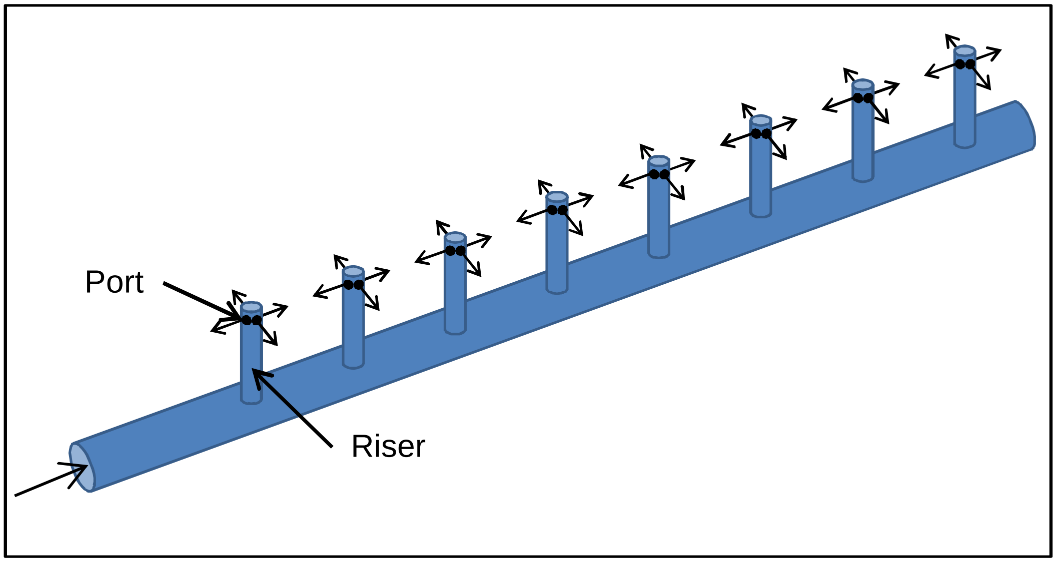
Recently collected field data and preliminary modeling of the effluent plume indicate that a Y-type diffuser may not provide the most effective mixing of the effluent with ocean water (see Chapter 6 of this report). Because of the predominately linear, north/south current flows at the location of the diffuser, a Y-type configuration presents the potential for the two independent plumes to combine and thereby decrease the dilution.The diffuser design is being optimized as part of the modeling effort to characterize the near-field and far-field dilution. Several alternative designs are being considered, but it is anticipated that a straight line linear diffuser will provide the most effective mixing.

Table 4-3 summarizes the characteristics of the preliminary diffuser design. A schematic representation of the diffuser is shown in Figure 4-8.

Table 4-3 Preliminary Diffuser Design for Rehoboth Beach Outfall

Parameter	Value
Diffuser length	120 ft (37 m)
Distance from shore	5,430 ft (1,830 m)
Port height from seabed	1.5 ft (0.5 m)
Port diameter	3 inches (0.075 m)
Number of risers	8
Number of ports per riser	4
Total number of openings (ports)	32
Alignment of ports	Horizontal

Figure 4-8 Example Diffuser Schematic Diagram (not to scale)



4.5.4 Construction Methods

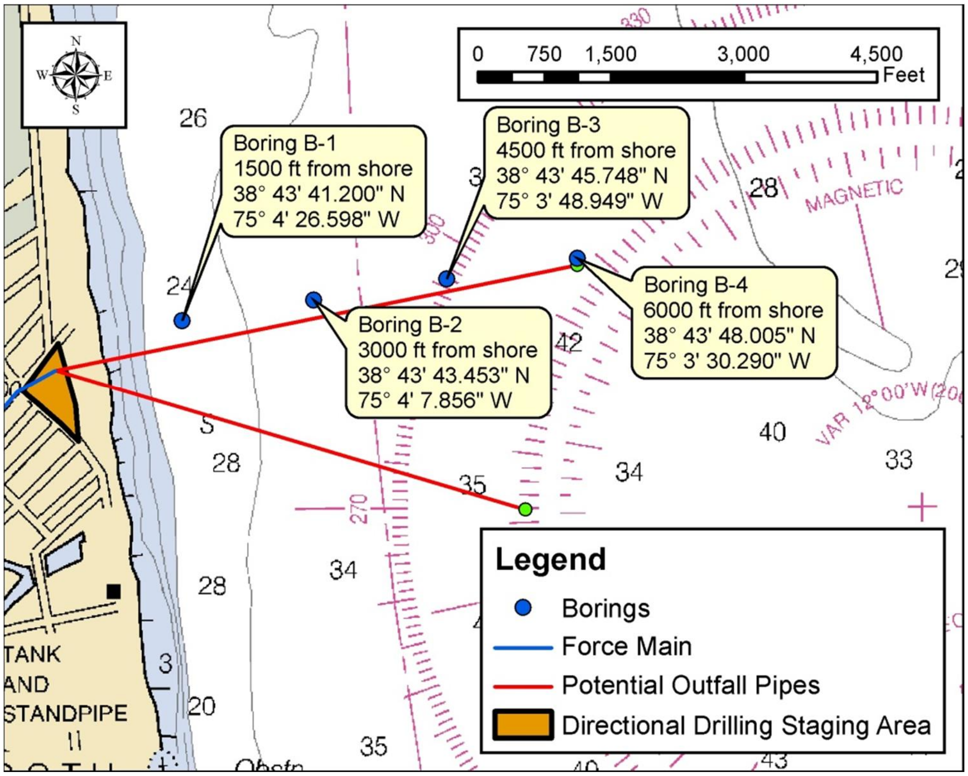
Two construction techniques will be utilized for construction of the outfall. They include:

- Horizontal Directional Drill (HDD)
- Excavate and backfill

The concept on which the EIS is based includes a combination of HDD and excavation. HDD would be used to install the outfall from the shore location in the parking lot area west of the dunes as far east towards the diffuser as is technically feasible. Meetings with several contractors with expertise in marine construction and large directional drill projects have concluded that it would push the limits of current experience to directionally drill a 24-inch pipe the entire 6,000 feet (1,830 meters). To help determine the maximum feasible length of HDD, soil borings were taken at four locations along the northern potential outfall pipe alignment, as shown in Figure 4-9. Boring logs are included in (Appendix H).

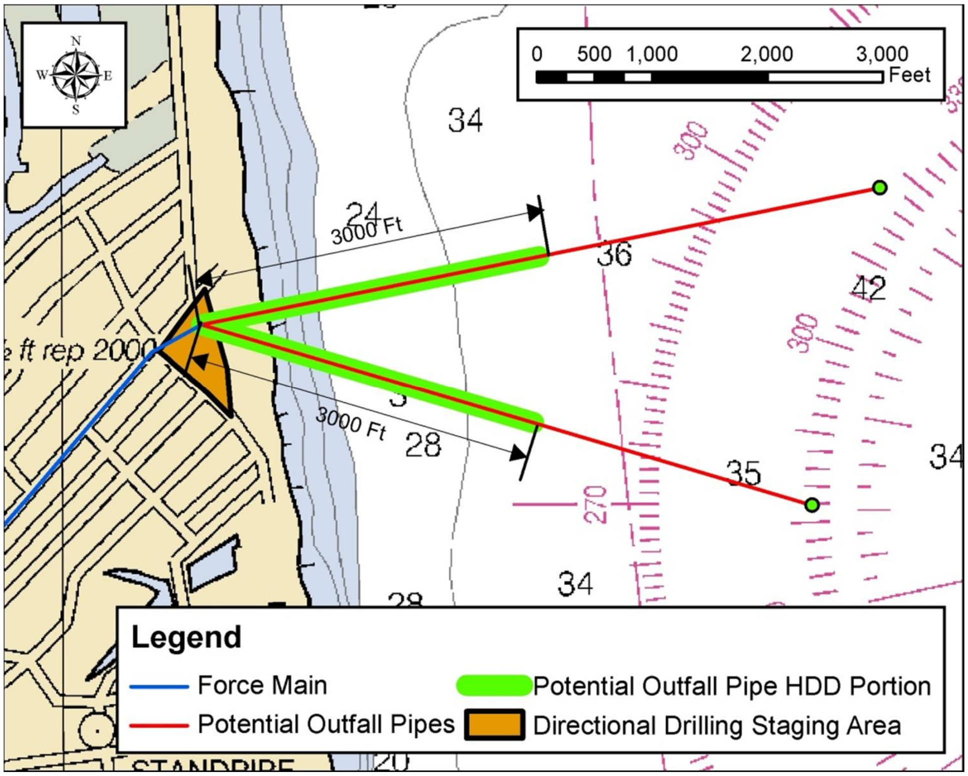
The borings indicate that the soils were generally comprised of fine to medium sand with some course sand and trace silt. Some thin layers containing soft to medium stiff clay were found near the surface. No rocks or hard gravel layers were found that could cause problems for HDD.

Figure 4-9 Marine Borings



In order to be conservative with respect to expectation for HDD, it is proposed that the pipe be installed by HDD to a point approximately 3,000 feet (915 meters) from the staging area, as shown in **Figure** 4-10. This would, at a minimum, avoid impacts associated with construction through the dune area, beach and surf zone. However, upon review of the obtained boring data, a contractor familiar with this type of construction has indicated that it is highly probable that the HDD portion of the outfall installation could extend beyond the 3,000 feet (915 meters) (Mears Group, Inc 2011a).

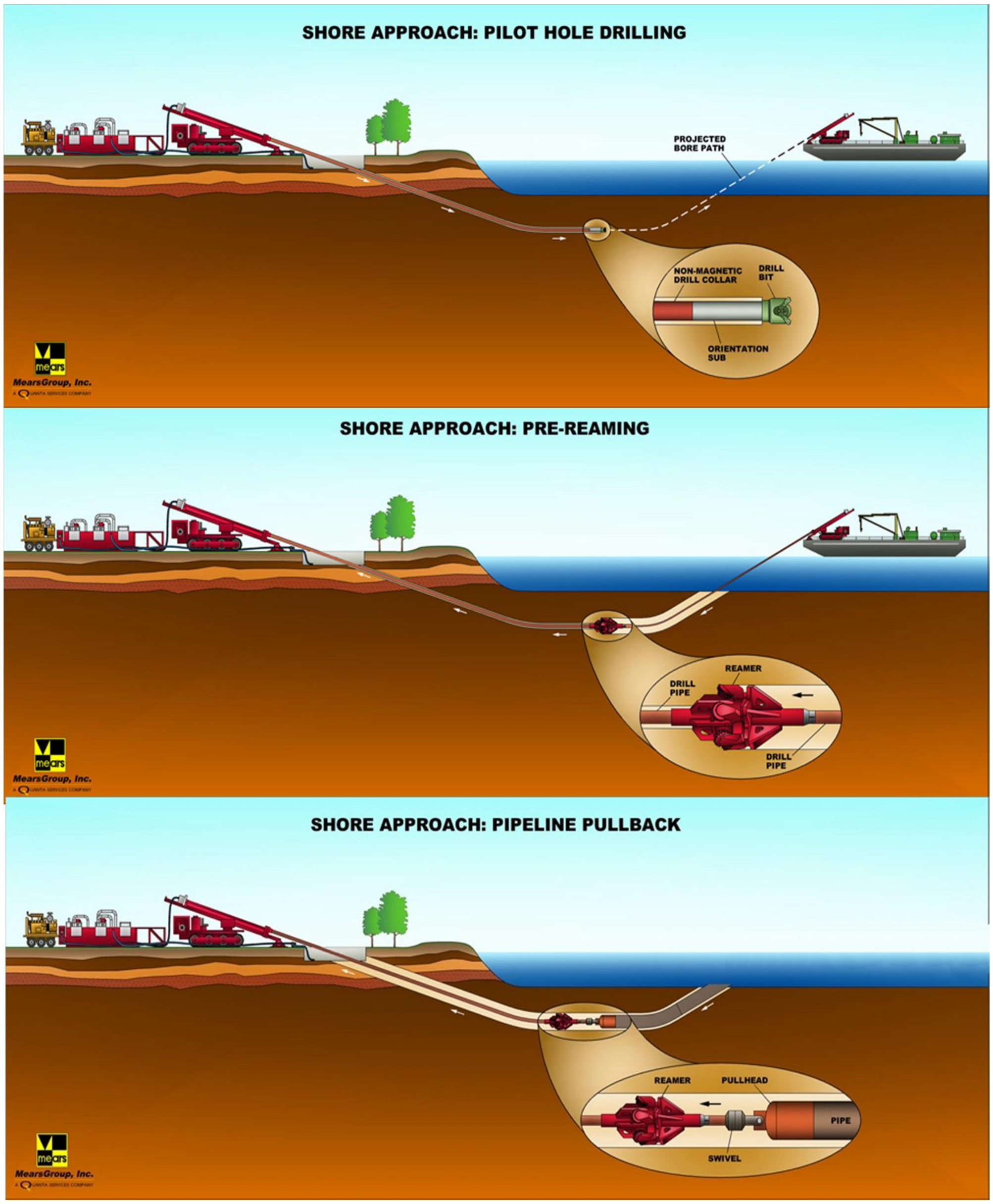
Figure 4-10 HDD Portion of the Proposed Outfall Pipe Alternatives



Initially, the drill pit is established in the parking lot area and the drilling rig and associated equipment mobilized to the site. A jack-up (lift) barge, stabilized by anchor, is mobilized to the offshore location to serve as the platform for the offshore drilling rig.

The directional drilling operation involves several steps as shown in Figure 4-11. First, a pilot hole is drilled from the shore. The progress and alignment of the pilot hole is closely monitored using various electronic survey tools. Then, the pilot hole is successively reamed to a larger diameter until the installation diameter is reached. The reaming operation alternates between the shore and the barge by pulling the boring machine east and west. Installation of a 24-inch pipe would require a bored diameter of approximately 32 inches. Finally, the pipeline, staged on land, is pulled from the offshore platform through the borehole. As the pullback progresses, successive lengths of pipe are fused together on the landside. Ideally, at least 2,000 foot (610 meter) lengths of pipe can be fused prior to installation and stored. This is because the pullback operation is intended to be a continuous 24/7 operation. It is proposed to temporarily store pre-fused lengths of pipe along Henlopen Avenue or along Route 1A. Time required for mobilization, completing the pilot hole and back reaming can take approximately three (3) months. The final installation of the pipe only requires several days of continuous effort. It is possible that the impact to Henlopen Ave can be constrained to these several days of construction if alternate sites for storing lengths of pre-fused pipe can be found.

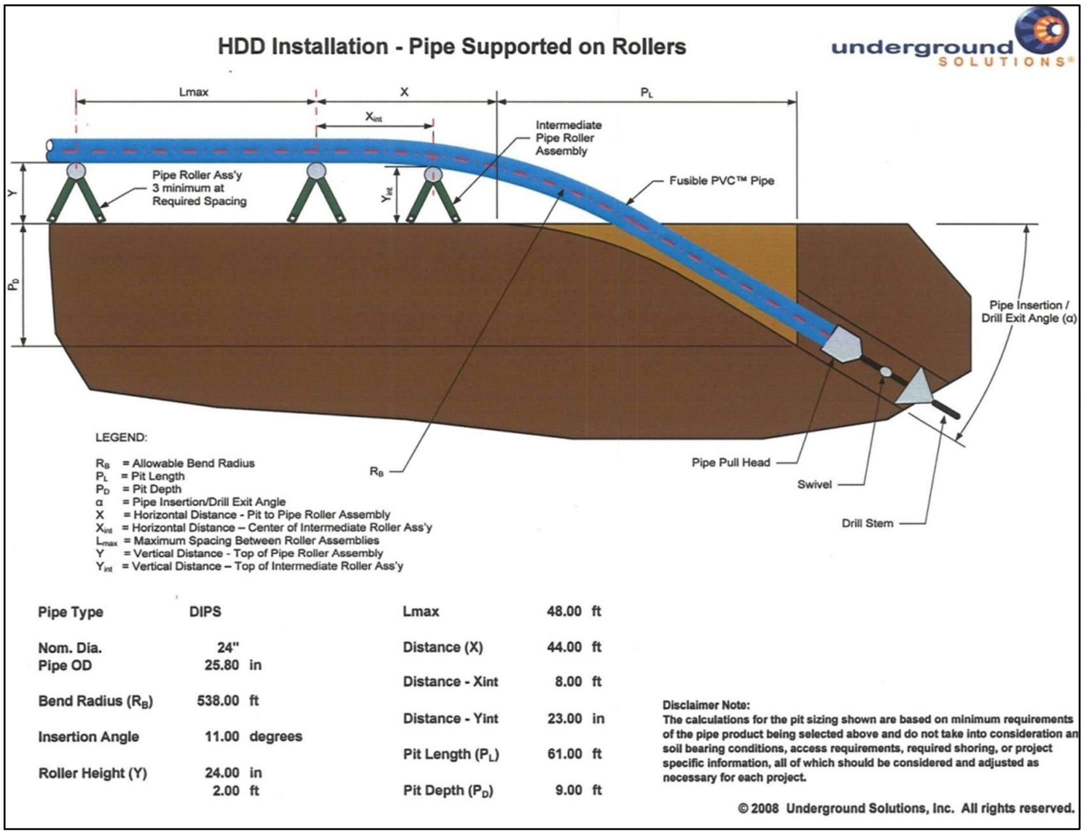
Figure 4-11 Mears Group's Horizontal Directional Drilling (HDD) process (Mears Group, Inc 2011)



Note: Pipe will be pulled from ocean side with pipe stored on land

Thus, there will be two work sites required: one on land for the HDD equipment and one offshore for the marine operations and pulling the pipe through the bore hole (see Figure 4-12). It may be possible to pull the pipe from the shore but that would require floating the pipe out behind a barge to steady the pipe. This is considered risky and highly weather dependent since there is very little tolerance when pulling the pipe for the pipe to become misaligned. Currents and foul weather could hamper this type of installation.

Figure 4-12 Typical pipe mobilization for pull through bore hole



The land site would be the parking lot area as previously described and shown in Figure 4-13. Typically an area 150 feet by 150 feet (46 meters by 46 meters) is required to set up the equipment, which includes the drill rig, mud recycling system, tanker truck, power unit and a small control shed (see Figure 4-14 and Figure 4-15). Potable water from a fire hydrant or some type of water storage facility is required. The drill pit itself is only approximately six (6) feet (1.8 meters) wide by 60 feet (18 meters) long by six (6) feet (1.8 meters) deep.

The shaded area in **Figure** 4-13 shows the area where the drill pit or pipe insertion pit would be located. The bend radius required to move the pipe from its storage point to the insertion pit is critical. With the proposed pipe size, the bend radius must be a minimum of 538 feet (164 meters). With the given alignment of Henlopen Avenue and the drill pit, the maximum bend radius available is 775 feet (236 meters) as shown in **Figure** 4-13 (Underground Solutions, Inc 2011).

Figure 4-13 Directional Drilling Staging Area (Underground Solutions, Inc 2011)

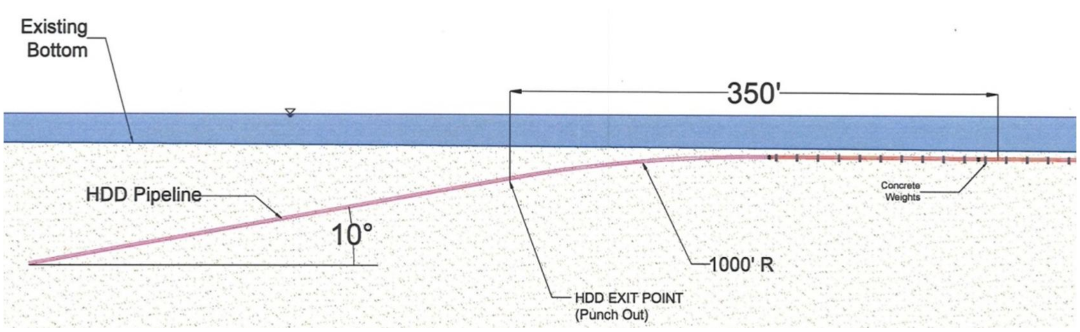
Figure 4-14 Typical HDD drill site

Figure 4-15 HDD drill rig

On the marine side, a jack-up barge would be positioned with a drill rig mounted on board that is capable of pulling the 24-inch pipe from the shore through the hole. Other equipment required includes that for the trench excavation and piling driving operation and a barge tender.

At the mid-point of the outfall installation (approximately 3,000 feet (914 meters) offshore) the outfall would reach the surface of the seabed as shown in Figure 4-16. A pit of several hundred feet in length is required to curve the pipe so that it is parallel to the ocean floor. It is expected that an 11.25° bend will be used to reach horizontal

Figure 4-16 HDD Exit Pit and Trench

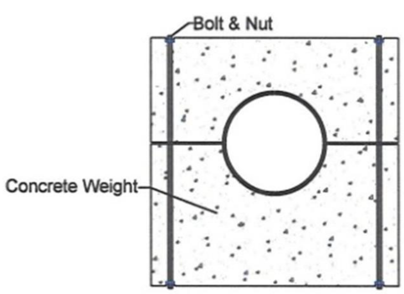


The remaining 3,000 feet (910 meters) of the outfall pipe would be constructed using excavation and backfill techniques. Most likely a bucket type or clamshell excavator would be required since it is best suited for detailed excavation. See Section 4.5.5 for a description of dredging techniques.

The trench will be excavated to a depth of 8 feet (2.4 meters) with a base of 4 feet (1.2 meters) and side slope of 3:1. A total of approximately 38,000 cubic yards of material will be moved and side cast next to the excavation area. As the excavation progresses, the pipe will be laid in the trench with the trench excavation leading the pipe by about 500 feet (152 meters). Once the entire pipe is laid in the trench, the backfill operation will commence. Hopper barges will carry the backfill ballast to the trench and the appropriately graded material will be placed by the hopper dredge. Hydrographic surveys will be performed during this operation to ensure the required coverage is provided.

The fusible PVC will be fabricated on land in 150 foot (46 meter) segments with flanged ends. A total of ten (10) concrete collars will be placed on each pipe segment at 15 foot (4.6 meter) increments to weight the pipe (see **Figure** 4-17). As each pipe segment is lowered to the trench, the flanged connections will be bolted by divers. The last 150 feet (46 meters) of pipe will transition from the trench to approximately 1.5 feet (0.5 meters) above the seabed for connection to the diffuser.

Figure 4-17 Typical Concrete Weight Cross Section



The pipe material will be high-density polyethylene (HDPE) or fusible polyvinyl chloride (PVC). These materials offer superior corrosion resistance. The pipe materials are buoyant and thus must be flooded and anchored during installation. Concrete collars will be installed on the pipe as it is installed to sink the pipe and anchor it into the trench. As construction progresses, sections of the pipe must be fused together. Extended lengths of pipe will be fused prior to installation and stored in order to minimize downtime during construction by either the HDD or excavation method.

As shown in Figure 4-18, the diffuser will be installed on pilings to ensure that it is anchored and the diffuser ports are not buried. Concrete collars will be placed on the pipe with piles driven through sleeves in the concrete weights to stabilize the diffuser. A section of the concrete collar is shown in Figure 4-19. The diffuser ports will be duck bill check valves. Installation of the diffuser can proceed concurrently with the outfall pipe.

Figure 4-18 Diffuser profile

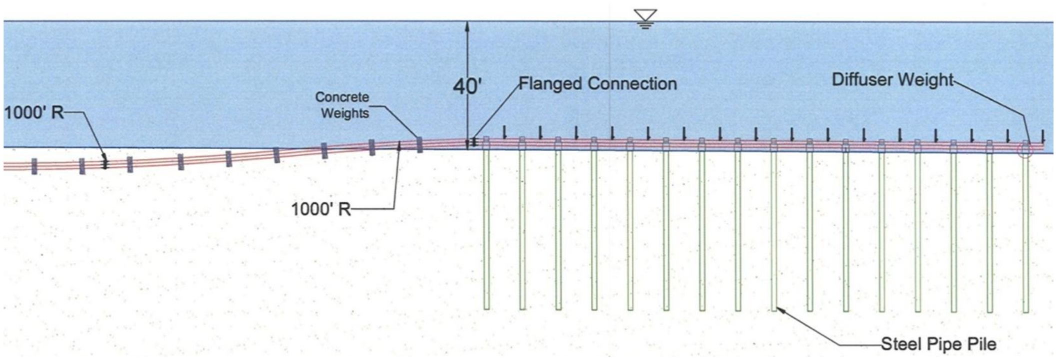
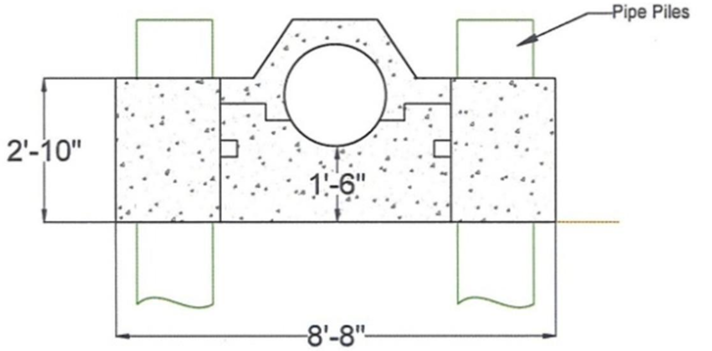


Figure 4-19 Diffuser Concrete Weight Connection



4.5.5 Dredging Techniques

4.5.5.1 Backhoe/Bucket/Clamshell Dredger

A backhoe dredger is typically mounted on a floating barge or jack-up platform and the dredged material loaded onto hopper barges for transport and deposition at the relocation site (Figure 4-20). With an appropriate number of hopper barges in support, continuous dredging is maintained.

The main advantage of the backhoe dredger is the ability to dredge a wide range of materials, including those that contain debris or (for large machines) boulders and to excavate smaller, defined areas such as a trench. Difficult materials, such as stiff clays and weak, weathered or fractured rocks, can be dredged by the larger dredgers.

As discussed in section 4.5.4, the soil borings taken at the locations shown in Figure 4-9 indicate that the soil contains trace clays and fine silts in some of the surface layers. The clamshell dredge will suspend some of the fine sediments and cause some temporary localized turbidity. The sediments will settle quickly and are not expected to create turbidity visible from the surface.

Figure 4-20 Clamshell dredge

4.5.5.2 Cutter Suction Dredger (CSD)

A cutter suction dredger (CSD) is a stationary hydraulic dredger. Stationary hydraulic dredgers are characterized by the diameter of the discharge pipeline and the mechanical power installed in the dredger. A CSD is shown in Figure 4-21.

CSDs operate by swinging about a central "working spud" using anchors and winches leading from the lower end of the ladder to anchors. By winching on alternate sides the dredger clears an arc(s) of cut, and then moves forward by pushing against the working spud using a spud carriage.

Medium to larger size dredgers typically work 24 hours per day /7 days per week using multiple crews. The noise and vibrations of a cutter suction dredger are such that crews cannot be accommodated on board and will come ashore at the end of each shift.

The cutter head is an assembly of cutting teeth on a rotary frame. The cutter head "basket" encloses the intake of the suction line. The cutter head rotates around the axis of the suction pipe, enabling the teeth on the cutter head to excavate material from the seabed. The cutting action of the cutter head dislodges the bed material. A mixture of material and water is drawn through the cutter head into the suction line.

While the dredge will cause some local turbidity, the turbidity will typically be in close proximity to the seabed rather than being released at the surface and falling through the entire water column.

The discharge line from the CSD delivers the fluidized material to the disposal area. Typically, discharge pipelines will be fitted with buoyancy sleeves or installed on pontoons floating aft of the dredger. Site constraints may dictate that it is necessary for sections of the pipeline to be submerged e.g. to allow vessel traffic to pass unimpeded or to protect the pipeline from the influences of waves and currents.

As stated previously, it is not likely that a CSD will be used for the dredging operation.

Figure 4-21 Cutter Suction dredge